

NATIONAL BUREAU OF STANDARDS REPORT

9301

PROGRESS REPORT

EXPOSURE TEST OF PORCELAIN ENAMELS ON ALUMINUM

Six Months Report

by

Margaret A. Rushmer

PORCELAIN ENAMEL INSTITUTE RESEARCH ASSOCIATESHIP
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C.



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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INTRODUCTION

Porcelain enamels for aluminum are one of the more recent innovations in the porcelain enamel industry. These enamels offer the building industry a versatile material that is not only light weight but it is also available in a variety of colors, textures, and glosses. However, exposure data for the early porcelain enamels on aluminum^{1/} indicated that the accelerated tests used with confidence to indicate the weatherability of porcelain enamels on steel were not reliable indicators for these new, lower firing enamels. Therefore, the Aluminum Council of the Porcelain Enamel Institute authorized a new exposure test consisting solely of enamels on aluminum to be conducted by the Porcelain Enamel Institute Research Associateship at the National Bureau of Standards.

The first inspection of the enamels included in this test was scheduled after six months' exposure. This report is a summary of the findings of that inspection. There was a delay in the return of the specimens exposed at Los Angeles so the data for these enamels is for eight months' exposure as indicated in later tables.

MATERIALS AND PROCEDURES

1. Enamels

Sixteen enamel systems were included in this test. These enamel systems are represented by nine colors, three gloss ranges, and both one and two coat enamels as indicated in Table 1. The initial 45° specular gloss values and the thicknesses of the enamels as well as their acid solubilities and acid spot test ratings are also reported in Table 1.

The enamels in this test have been coded for easy identification. Each enamel system can be identified by the first two code letters, while the different fabricators for each enamel system are indicated by the third code letter. The differences between the enamel systems are readily apparent (see Table 1) for all systems except AA and AZ. These systems were planned to be two coat enamels having significantly different thicknesses. However, this difference did not materialize during manufacture of the specimens.

If small variations in milling and firing of the enamels by the different fabricators are taken into account there are, in effect, 51 different enamels included in this test.

2. Test Specimens

Each enamel was applied to a 3 X 5 foot sheet of 0.064 inch aluminum alloy. After the enamel was fired the sheet was cut, with a band saw, into seventy-eight 4-7/16 inch square and nine 4 X 6 inch exposure specimens. This was done to produce more uniform specimens than could be obtained by hand spraying individual small metal blanks.

3. Exposure Sites

Three of the 4-7/16 inch square specimens of each enamel were exposed on the roofs of Federal Government buildings in New York City, New York; Los Angeles, California; and Washington, D. C.; as well as the roof of the Stores Department Building in Montreal, Canada. Three of the 4 X 6 inch specimens of each enamel were exposed at a ground site of the International Nickel Company's Corrosion Laboratory at Kure Beach, North Carolina - 80 feet from the ocean.

The specimens were exposed at 45° and face south at all sites except Kure Beach, where they are exposed at 30° and face the ocean at east-southeast.

In addition to the exposed specimens, three specimens of each enamel have been designated as "storage" enamels. These enamels were set aside in a dark, dry place and allowed to age indoors.

After six months exposure, the exposed specimens were returned to the laboratory for analysis. These specimens along with the storage specimens were cleaned and measured to determine the changes resulting from exposure, storage and cleaning.

The remaining 69 specimens of each enamel were kept for use in laboratory tests and for the development of new tests as needed.

RESULTS

1. Cleaning of Specimens

In previous exposure tests^{1,2/} the specimens exposed at one of the sites required scouring before the enamel surface could be examined. These scouring

treatments tended to increase the gloss readings of the enamels making them incomparable with the enamels exposed at the other sites. Therefore, in this test it was decided that the enamels should be scoured both before and after exposure. In order to determine a suitable cleaning procedure, enamels in the three gloss ranges were scoured with a commercial cleanser (Bon Ami), Potters' Flint, and calcium carbonate. Gloss readings taken after scouring for a predetermined number of strokes indicated that scouring with calcium carbonate increased the gloss the least of the three scouring powders tested (see Fig. 1 and 2). On the basis of this information, it was decided to clean the specimens by 1) scouring 30 strokes with a sponge dampened with a one percent, by weight, solution of trisodium phosphate and sprinkled with calcium carbonate, 2) rinsing with tap water, 3) rinsing with distilled water, and finally 4) rinsing with alcohol.

When the specimens were returned to the laboratory at the National Bureau of Standards for inspection, it was noted that the specimens exposed at Kure Beach appeared quite clean, while increasingly heavier dirt films were noted on the specimens exposed at Washington, Los Angeles, Montreal, and New York City. The cleaning treatment outlined above was satisfactory for cleaning the specimens exposed for six months at all sites except New York City. The dirt film on the specimens exposed at this site was approximately 0.03 mils thick and was extremely difficult to remove. The cleaning procedure was altered to scouring with calcium carbonate on a cheesecloth until the specimens were clean. They were then rinsed as described above.

It was observed while cleaning the specimens exposed at New York City that the high gloss enamels cleaned in less time (approximately two minutes) than the low gloss enamels (approximately three minutes). However, these values may be in error since the time required to clean all of the specimens was not recorded.

2. Gloss and Color

The 45° specular gloss of the enamels was measured at four orientations near the center of the specimen, both before and after exposure. The gloss is reported as the percentage gloss retained after exposure.

It should be mentioned that shortly after the gloss on the specimens exposed for eight months at Los Angeles was measured, it was observed that the gloss meter was out of adjustment. It is not certain whether it was in perfect operating condition at the time the Los Angeles specimens were measured. Therefore, these gloss values may be in error. If the gloss meter was not in proper adjustment, it will probably be evident at the one-year inspection of these enamels at which time the eight months' gloss data for Los Angeles will either be kept or be discarded.

The color change of the specimens was measured with a color difference meter. One of the three storage panels was used as the standard in measuring the color difference. This was done to obtain maximum efficiency with this type of instrument. The storage specimens were, in turn, measured against calibrated NBS color standards to determine whether the enamels changed color during storage. The color change is reported as color retention, which is 100 minus the color difference in NBS units^{3/}.

The average percentage gloss retained and color retention for the three specimens of each enamel exposed at each site as well as the storage enamels are given in Table 2.

3. Comparison of Exposure Sites

The average values for color retention and percentage gloss retained for all enamels exposed at each site are given in Table 3. A two-sided sign test^{4/} performed on the data in Table 2 indicated a significant difference between Kure Beach and all other sites for both gloss and color. A significant difference was also noted for one of the two parameters when Washington was compared with New York, Montreal, and Los Angeles and when Los Angeles and New York were compared. However, since the significant difference occurred for only one of the parameters, the difference in site severity was not considered to be significant at this time. However, this may change with increased exposure times.

4. Comparison of Enamel Colors

The average color retention and percentage gloss retained for each of the nine colors included in the test are presented in Table 4. It is obvious that the red enamels showed the poorest color retention at all sites. However, all the red enamels failed the 15-second nitric acid spot test included in the Specification for Porcelain Enamel on Aluminum for Weather Exposure; PEI:ALS-105. In addition, all the red enamels failed the cupric sulfate test for color retention which is included in the Specification for Architectural Porcelain Enamel on Steel for Exterior Use; PEI: S-100.

There was very little difference between the color stability of the remaining eight colors. The slight differences that did occur were not considered to be significant at this time. Again this may change with longer exposure time.

5. Comparison of Enamels in the Different Gloss Ranges

The enamels were divided into three gloss ranges as indicated previously. The low gloss enamels had an initial 45° specular gloss value of 35 or less, the medium between 36 and 69 and the high 70 or over. Table 5 shows the average gloss and color data for these enamels. The data in this table are based on the actual initial gloss values given in Table 1, not the nominal values. The color retention data are considered to be a better criteria for comparing the enamels because small changes in gloss result in increasingly larger percentage losses as the initial gloss of the enamel is lowered, also small changes in color are much more noticable than large changes in gloss. When comparing the color retention data for these three groups of enamels, it is easily seen that there are no significant differences among these three gloss ranges at this time.

6. Comparison of Coating Thicknesses

The enamels included in this test were applied in either one or two coat systems. This was to determine whether the one coat systems, which are less expensive to produce, are as durable as the two coat systems. The data in Table 6 indicate a slight difference between these two systems. Again this difference is not significant after this short exposure time.

7. Comparison with Enamels in Previous Exposure Tests

Data comparing three sets of porcelain enamels exposed for six months at Kure Beach-80 are presented in Table 7. Two sets of data are for enamels on aluminum, one from this test and one from a test initiated in 1956¹/. The third set of data is for the acid-resistant enamels on steel included in the 1956 test. There are only minor differences among these three sets of enamels at six months. However, longer exposure times were found to produce marked differences between the two sets of enamels included in the 1956 test.

8. Spall Resistance

Triplicate specimens of each enamel were tested for 96 hours in ammonium chloride for spall resistance. A slight tendency to spall was noted for eight enamels. However, the spalled areas were so small that they did not constitute failure. Likewise, some enamels exposed at all sites except Washington exhibited a few very small spalled or corroded areas on one of the three specimens exposed. These very small areas are not considered failures at this time.

SUMMARY

In summary it can be said that after six months' exposure at Kure Beach, Washington, Montreal, New York City, and Los Angeles, triplicate specimens of 51 different porcelain enamels on aluminum:

1. were easily cleaned except those exposed at New York City,
2. appeared to have good color stability except for the red enamels,
3. showed no significant difference between different gloss or thickness ranges of enamel, and

4. showed greater changes in gloss and color at Kure Beach than at any of the other exposure sites.

The next inspection of these enamels is planned after they have been exposed for one year.

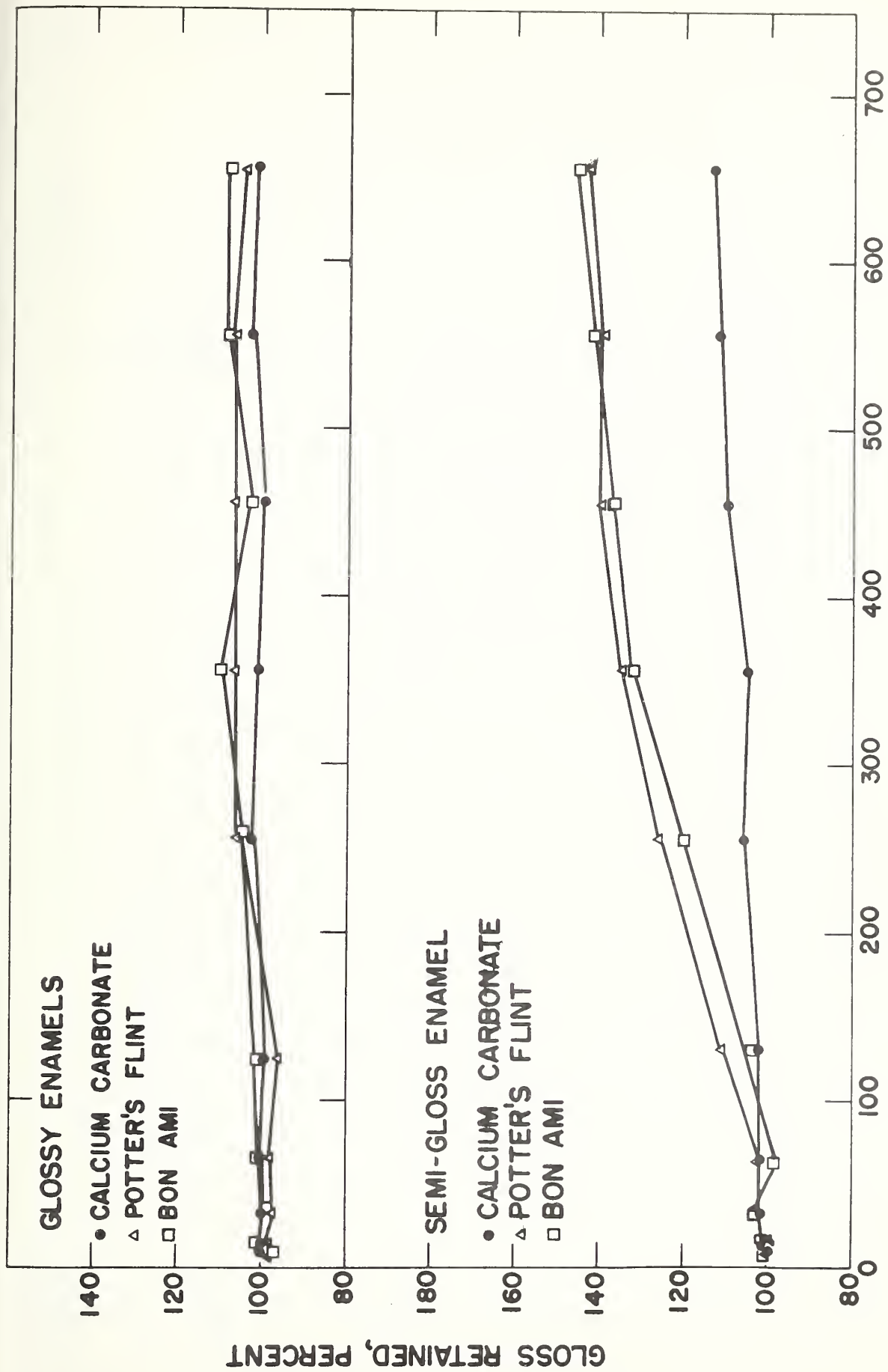


Figure 1. Effect of scouring on the gloss retention of glossy and semi-gloss enamels.

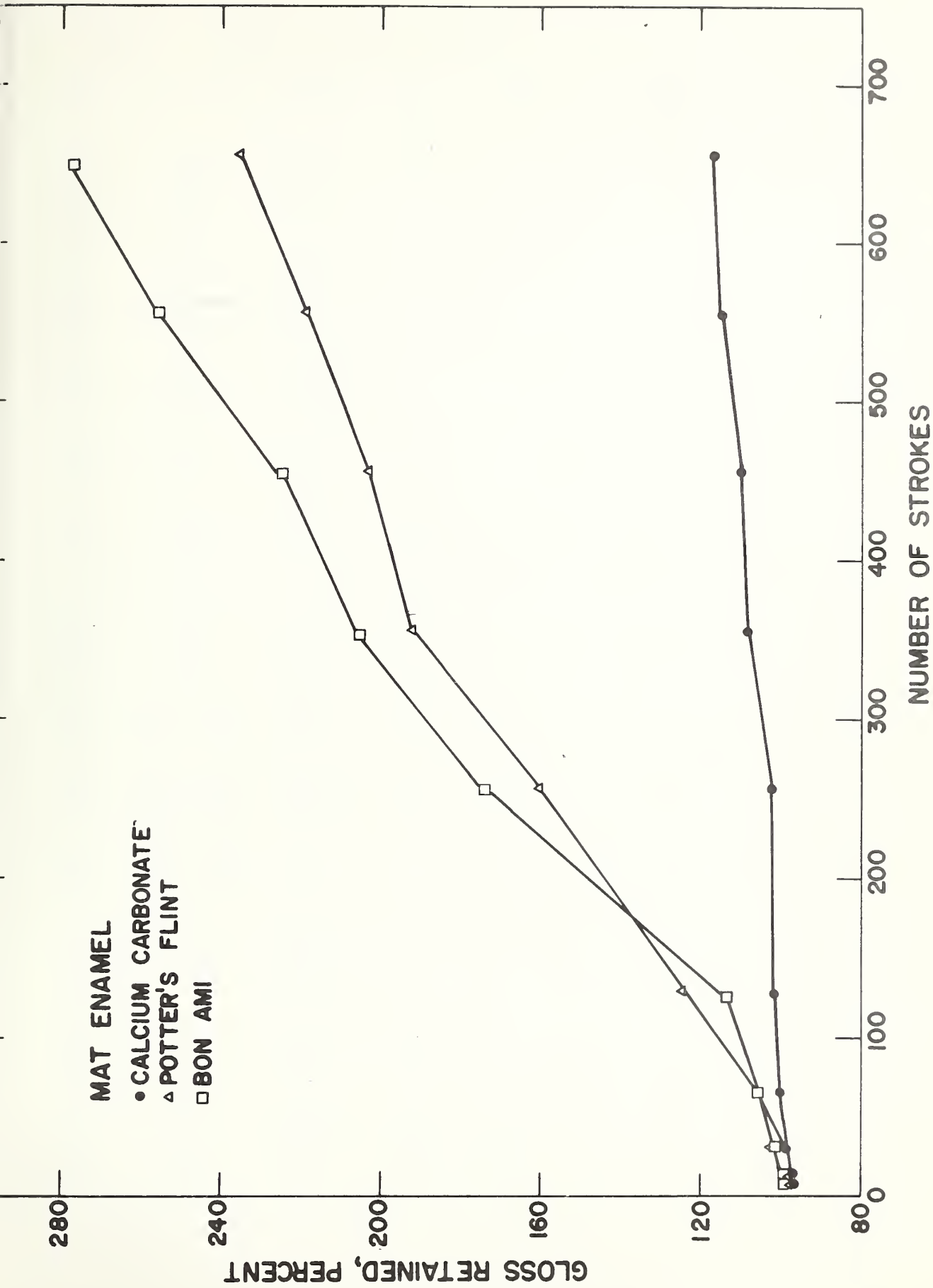


Figure 2. Effect of scouring on the gloss retention of a low gloss enamel

Table 1. Summary of Initial Data for Porcelain Enamels on Aluminum

Enamel	Visual Color	Nominal Gloss	45° Specular Gloss	Number of Coats	Thickness mils	Acid Solubility mg/in ²	Acid Spot Test Ratings
AA-A	White	High	70.1	Two	4.5	5.5	A
AA-B	White	High	74.2	Two	4.3	5.9	A
AA-C	White	High	71.5	Two	3.4	5.0	AA
AA-D	White	High	71.9	Two	6.5	12.7	AA
AB-A	White	Medium	56.8	Two	4.0	7.2	B
AB-C	White	Medium	55.6	Two	4.0	4.9	A
AB-D	White	Medium	28.9	Two	6.2	7.9	A
AC-A	White	High	74.5	One	3.5	6.4	A
AC-B	White	High	71.8	One	2.8	11.3	AA
AC-C	White	High	70.5	One	3.3	9.9	AA
AD-A	White	Medium	55.0	One	2.8	6.2	AA
AD-B	White	Medium	68.3	One	4.3	6.7	B
AD-C	White	Medium	42.4	One	3.2	7.1	B
AD-D	White	Medium	34.9	One	2.7	12.4	A
AE-A	Black	High	75.6	One	2.4	6.5	A
AE-B	Black	High	78.0	One	1.6	10.1	A
AE-C	Black	High	78.1	One	2.0	12.1	A
AE-D	Black	High	75.0	One	3.4	15.5	B
AF-A	Black	Medium	78.4	One	1.5	14.2	B
AF-B	Black	Medium	58.5	One	2.7	9.0	B
AF-C	Black	Medium	76.8	One	3.1	10.1	C
AG-B	Black	Low	26.0	One	3.0	12.5	B
AG-C	Black	Low	12.6	One	2.0	7.5	A
AH-A	Red	High	46.9	One	2.8	8.1	A
AH-B	Red	High	85.3	One	3.1	8.8	B
AH-C	Red	High	85.6	One	3.1	6.5	B
AH-D	Red	High	82.0	One	1.9	10.5	B
AO-A	Dark Green	High	78.8	One	3.2	19.9	A
AO-B	Dark Green	High	79.8	One	1.6	10.1	A
AO-D	Dark Green	High	78.3	One	2.1	17.0	A
AP-A	Light Green	Medium	42.4	Two	6.4	12.3	B
AP-B	Light Green	Medium	38.5	Two	4.1	6.4	A
AP-C	Light Green	Medium	30.2	Two	4.0	6.2	A
AP-D	Light Green	Medium	45.3	Two	6.4	10.0	A
AR-A	Light Green	Low	9.6	Two	3.2	4.4	A
AR-B	Light Green	Low	7.3	Two	2.7	5.5	A
AR-C	Light Green	Low	5.7	Two	4.3	8.1	A
AS-A	Gray	Medium	64.9	Two	5.0	13.4	A
AS-B	Gray	Medium	61.6	Two	5.5	7.4	AA
AS-C	Gray	Medium	62.2	Two	3.9	5.4	A
AT-A	Blue	Medium	32.9	Two	4.4	6.2	A
AT-B	Blue	Medium	54.8	Two	3.6	7.0	A
AT-C	Blue	Medium	62.4	Two	2.9	6.1	AA
AU-A	Brown	Medium	50.0	Two	7.2	5.3	A
AU-B	Brown	Medium	35.4	Two	6.4	7.5	A
AU-C	Brown	Medium	46.6	Two	4.4	7.6	A
AW-A	Yellow	Medium	62.4	Two	5.8	7.8	A
AW-B	Yellow	Medium	63.1	Two	4.1	8.7	A
AW-C	Yellow	Medium	80.9	Two	5.0	18.6	A
AZ-A	White	High	72.0	Two	4.2	9.5	A
AZ-B	White	High	71.2	Two	2.7	5.2	A

Table 2. Summary of Six Months' Exposure Data for Porcelain Enamels on Aluminum

Enamel	Kure Beach Gloss Color		Washington Gloss Color		Montreal Gloss Color		New York Gloss Color		Los Angeles*		Storage Gloss Color		Visual Color
AA-A	85.5	99.4	93.2	99.5	93.8	99.5	98.3	99.4	95.6	99.5	98.8	99.9	White
AA-B	94.0	99.3	92.7	99.5	98.6	99.4	94.5	99.7	103.0	99.3	99.2	99.7	White
AA-C	90.7	99.0	90.7	98.8	92.0	98.9	92.3	99.2	96.0	99.0	99.1	99.9	White
AA-D	76.0	98.3	94.6	97.8	100.0	97.8	101.1	97.9	101.0	98.2	99.2	99.8	White
AB-A	81.2	98.8	82.8	98.8	83.9	98.7	95.9	98.1	84.9	98.7	99.6	99.9	White
AB-B	79.6	99.6	81.0	99.5	82.7	99.4	83.9	99.2	83.6	99.4	98.1	99.8	White
AB-D	75.3	98.5	93.3	98.9	80.0	98.9	100.5	98.3	79.6	98.4	99.2	99.9	White
AC-A	90.2	99.4	93.0	99.3	98.6	98.6	96.3	99.3	102.6	99.1	99.0	99.4	White
AC-B	85.8	98.7	92.8	99.1	101.3	99.0	103.4	99.0	102.1	98.6	99.3	99.8	White
AC-C	90.6	98.3	93.7	98.6	98.3	98.9	99.0	98.7	98.2	98.9	99.8	99.7	White
AD-A	87.6	98.9	91.7	99.4	90.3	99.5	100.9	99.2	90.3	99.4	99.6	99.7	White
AD-B	89.0	99.4	89.8	99.6	90.5	99.5	97.4	99.1	92.4	99.4	99.6	99.8	White
AD-C	82.8	98.1	90.9	99.0	88.6	99.1	105.3	98.1	87.5	98.5	98.8	99.7	White
AD-D	87.5	98.1	98.0	96.9	87.7	98.8	104.7	98.1	88.6	98.4	99.6	99.7	White
AE-A	76.4	99.1	81.3	98.6	82.1	99.8	82.1	99.8	80.5	99.8	97.8	99.6	Black
AE-B	65.1	98.6	86.5	99.8	88.8	99.5	84.6	99.6	87.9	99.7	98.8	99.8	Black
AE-C	72.6	98.9	89.4	99.6	91.9	99.5	86.7	99.6	91.1	99.4	98.4	100.0	Black
AE-D	71.1	98.6	82.2	98.0	87.4	99.7	83.3	98.9	85.5	99.4	98.6	99.5	Black
AF-A	65.6	98.4	85.7	99.2	90.4	99.3	82.1	98.5	85.7	99.6	99.0	99.7	Black
AF-B	69.7	99.1	93.2	98.8	95.6	99.4	88.3	99.4	96.1	99.3	98.5	99.8	Black
AF-C	72.2	98.4	84.5	98.8	88.2	99.8	84.4	99.3	87.5	99.6	98.8	99.6	Black
AG-B	82.0	97.6	100.5	98.6	81.3	98.9	76.2	98.4	79.5	99.3	98.6	99.7	Black
AG-C	46.9	98.2	105.7	99.4	31.8	99.5	35.9	98.3	33.2	99.4	96.2	99.4	Black
AH-A	90.8	97.5	95.8	98.1	97.8	97.5	118.3	97.6	103.7	97.4	100.3	99.3	Red
AH-B	64.3	93.0	72.3	94.6	75.4	95.2	81.7	96.6	76.8	95.5	100.1	99.7	Red
AH-C	73.9	90.1	70.8	91.9	77.3	92.8	75.5	91.5	77.6	91.9	100.1	99.4	Red
AH-D	59.7	83.6	74.7	88.9	82.8	89.7	79.0	95.2	83.2	91.0	99.6	99.6	Red
AO-A	76.6	95.4	82.1	99.1	83.8	99.3	80.2	99.7	83.3	99.9	99.5	99.7	Dark Green
AO-B	72.5	99.5	84.0	99.5	83.4	99.7	83.0	99.7	84.6	99.8	99.2	99.7	Dark Green
AO-D	74.1	97.8	83.8	98.5	87.8	99.4	81.0	99.4	87.0	98.9	98.9	99.7	Dark Green
AP-A	82.2	98.7	95.5	99.4	92.1	99.5	102.3	99.4	90.2	99.3	99.2	99.8	Light Green
AP-B	75.5	99.4	82.9	99.4	78.6	99.6	86.3	99.6	77.0	99.6	98.7	99.8	Light Green
AP-C	73.9	99.5	85.7	99.0	76.4	99.5	85.8	99.6	72.5	99.2	98.2	99.8	Light Green
AP-D	87.5	99.1	93.9	99.0	91.7	99.3	95.4	99.5	88.0	99.2	98.1	99.8	Light Green
AR-A	47.0	99.6	111.8	99.5	62.4	99.6	54.2	99.3	25.5	99.6	94.5	99.7	Light Green
AR-B	0.0	99.4	82.5	99.6	4.4	99.7	0.0	98.8	0.0	99.6	100.0	99.8	Light Green
AR-C	0.0	99.4	85.7	99.6	0.0	99.7	0.0	98.8	0.0	99.5	100.5	99.7	Light Green
AS-A	78.2	98.7	90.2	99.4	91.2	99.5	91.7	99.4	92.1	99.5	98.7	99.9	Gray
AS-B	83.7	98.9	83.0	99.3	83.0	99.4	85.0	99.2	82.5	99.3	99.1	99.6	Gray
AS-C	92.5	99.8	91.8	99.6	91.7	99.8	90.4	99.6	93.3	99.8	99.0	99.7	Gray
AT-A	75.2	99.0	83.8	98.9	68.3	99.1	80.4	98.9	71.4	99.1	98.8	99.8	Blue
AT-B	79.8	98.6	93.8	98.9	91.0	99.3	91.5	98.6	90.9	97.9	99.4	99.9	Blue
AT-C	81.5	98.7	78.8	97.1	80.9	99.3	83.3	99.7	82.0	99.0	98.8	99.8	Blue
AU-A	89.1	99.3	84.3	99.7	81.2	99.8	88.3	99.7	87.7	99.7	99.1	99.6	Brown
AU-B	75.7	99.2	92.4	99.6	79.9	99.8	98.0	99.5	80.3	99.8	98.2	99.8	Brown
AU-C	87.4	99.8	94.5	99.5	91.5	99.8	95.1	99.6	91.4	99.8	98.6	99.9	Brown
AW-A	81.4	99.2	82.7	99.4	85.7	99.6	86.2	99.5	85.3	99.6	98.8	99.9	Yellow
AW-B	78.8	99.3	93.3	99.2	94.2	99.2	95.6	99.3	93.7	99.3	98.5	99.8	Yellow
AW-C	72.1	98.9	84.6	99.4	90.3	99.4	91.4	99.4	91.7	99.4	99.7	99.9	Yellow
AZ-A	100.9	97.7	93.5	99.3	102.4	99.1	103.4	99.2	104.1	98.9	100.7	99.9	White
AZ-B	94.2	99.1	90.6	99.0	93.9	99.3	90.9	99.2	99.1	98.8	100.0	99.7	White
Average	75.8	98.2	88.8	98.6	81.7	98.9	85.7	98.8	82.9	98.9	99.0	99.7	

* The data for Los Angeles are after eight months' exposure.

Table 3. Average Percentage Gloss Retained and Color Retention of Porcelain Enameled Aluminum at the Different Exposure Sites

Exposure Site	Color Retention	Percentage Gloss Retained
Kure Beach-80	98.2	75.8
Washington	98.6	88.8
Montreal	98.9	81.7
New York	98.8	85.7
Los Angeles	98.9	82.9
Storage	99.7	99.0

Table 4. Average Color Retention and Percentage Gloss Retained for the Different Colors of Porcelain Enameled Aluminum.

Enamel Color	Kure Beach	Color Retention					Percentage Gloss Retained					Storage
		Wash- ington	Mont- real	New York	Los Angeles	Storage	Kure Beach	Wash- ington	Mont- real	New York	Los Angeles	Storage
Red	91.1	93.4	93.8	95.2	94.0	99.5	72.2	78.4	83.3	88.6	85.3	100.0
Blue	98.8	98.3	99.2	98.9	98.7	99.8	78.8	85.5	80.0	85.1	81.4	99.0
White	98.8	98.3	99.2	98.9	98.9	99.8	86.9	92.6	92.7	98.0	94.3	99.4
Black	98.5	99.0	99.5	99.1	99.5	99.7	69.1	89.9	81.9	78.2	80.8	96.9
Dark Green	97.6	99.0	99.5	99.6	99.5	99.7	74.4	83.3	85.0	81.4	85.0	99.7
Yellow	99.1	99.3	99.4	99.4	99.4	99.9	77.4	86.9	90.1	91.1	90.2	99.0
Gray	99.1	99.4	99.6	99.4	99.5	99.7	84.8	88.3	88.6	89.0	89.3	98.9
Light Green	99.3	99.4	99.6	99.3	99.4	99.8	52.3	91.1	57.9	60.6	50.5	98.4
Brown	99.4	99.6	99.8	99.6	99.8	99.7	84.1	90.4	84.2	93.8	90.2	98.6

Table 5. Average Color Retention and Percentage Gloss Retained for the Different Gloss Ranges of Porcelain Enameled Aluminum Exposed for Six Months.

Color Retention

Gloss Range	Kure Beach	Washington	Montreal	New York	Los Angeles*	Storage
Low	98.8	99.2	99.4	98.7	99.2	99.7
Medium**	99.0	99.0	99.5	99.2	99.3	99.8
High**	98.6	99.1	99.2	99.2	99.3	99.8

Percentage Gloss Retained

Gloss Range	Kure Beach	Washington	Montreal	New York	Los Angeles*	Storage
Low	46.6	94.7	46.9	49.6	50.0	98.3
Medium**	82.1	88.9	87.1	92.9	87.8	98.9
High**	78.4	86.3	90.4	88.8	93.0	99.6

* The data for Los Angeles are after eight months' exposure.

** The averages for the medium and high gloss enamels were calculated omitting the red enamels since they showed such great color changes.

Table 6. Average Color Retention and Percentage Gloss Retained for One and Two Coat Systems of Porcelain Enameled Aluminum Exposed for Six Months.

Color Retention						
Number of Coats	Kure Beach	Washington	Montreal	New York	Los Angeles*	Storage
One**	98.5	98.9	99.3	99.1	99.3	99.7
Two	99.1	99.2	99.4	99.2	99.2	99.8

Percentage Gloss Retained						
Number of Coats	Kure Beach	Washington	Montreal	New York	Los Angeles*	Storage
One**	76.8	90.0	86.7	87.1	86.5	98.9
Two	75.7	88.7	80.8	84.3	80.1	98.9

* The data for Los Angeles are after eight months' exposure.

** The red enamels were omitted when the average values for the one coat systems were calculated because they showed such great color changes.

Table 7. Comparison of Porcelain Enamels on Aluminum with Other Porcelain Enamels Exposed for Six Months at Kure Beach-80

Exposure Test	Gloss	Color	Number
Present Aluminum Test	75.8	98.2	51
Aluminum Enamels in 1956 Test	80.5	98.5	10
Acid-Resistant Enamels on Steel, 1956 Test	77.8	98.4	25

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